

## II - PHYSIOGRAPHY AND GLACIAL GEOLOGY OF ALLEGANY COUNTY AND VICINITY

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### INTRODUCTION

In the text to follow, the location of many geographic features is indicated in parenthesis. The parenthetical enclosure names the topographic sheet and the portion of that sheet, divided into ninths by parallels and meridians at 5 minute intervals, on which the feature can be found. The nine sections of each map are indicated by letters as shown at the right:

NW	N	NE
W	C	E
SW	S	SE

### PHYSIOGRAPHY

The field area is part of the Appalachian Plateau province, a mature, medium textured upland of moderate relief developed on sedimentary rocks with small southward regional dip. Most of the area bears the imprint of moderate glaciation during two or more episodes of the Pleistocene Epoch and for this reason belongs to the Southern New York section of the Appalachian Plateau. In the southwest corner of the field area a portion of Cattaraugus County is part of the Salamanca re-entrant, the northernmost area in eastern United States to escape glaciation. As such it lacks the characteristic open valleys, glacially scoured summits and drift deposits of the Southern New York section. Instead the landscapes of the Salamanca re-entrant are shaped primarily by normal processes of mass wasting and stream erosion and therefore belong to the unglaciated Kanawha section of the Appalachian Plateau.

The field area includes the most rugged topography in western New York. Maximum relief is more than 1400 feet and local relief of 600 to 800 feet is rather general along the south border. Alma Hill (Belmont, SE), with summit elevation of 2548 feet above sea level, is the highest point in New York west of the Catskill plateau. The lowest elevation in Allegany County is below 1120 feet where the Genesee River crosses into Wyoming County northeast of Wiscoy (Portage, SE). Local relief decreases generally northward but even near the Wyoming county line is commonly more than 500 feet.

The major drainage divide between watersheds of the Atlantic Ocean and the Gulf of Mexico passes northwest across Allegany and Cattaraugus Counties. Most of the field area lies within the drainage basin of the Genesee River, the only river which flows across New York state. With headwaters across the state line in Pennsylvania, the Genesee flows northward into Lake Ontario near Rochester, and so is tributary to the St. Lawrence River. Northeastern Allegany County and adjacent parts of Steuben County lie in the watershed of the Canisteo River which is tributary to the Chemung and thus also to the Susquehanna. A small portion of southwestern Allegany County and adjacent Cattaraugus County lie west of the major divide so that runoff in these areas ultimately reaches the Gulf of Mexico by way of the Allegheny, Ohio and Mississippi Rivers.

### INFLUENCE OF ROCK STRUCTURE ON TOPOGRAPHY

The structure of underlying Paleozoic sedimentary rocks plays a subordinate role in topographic development except southwest of the Allegheny River. The stratigraphic section which is exposed at the surface or concealed beneath the drift mantle consists of interbedded shale and sandstone with a number of locally conspicuous conglomerate layers in the upper part of the column. The rocks are of Upper Devonian age and are

progressively younger southward to the state line near which are scattered remnants of Pennsylvanian conglomerate. Although the regional dip is southward at a fraction of a degree, the strata are warped into shallow open folds which trend northeastward and cause local variation and reversal of dip.

In a general way, the stream pattern of the southern portion of the Wellsville and Belmont quadrangles reflects the influence of structure. Beech Hill (Wellsville, S and SE) lies along the trend of the Sharon-Watkins anticline, one of the few structures with significant closure. Honeoye (Wellsville, SW) and Cryder Creeks (Wellsville, S & SE) parallel the limbs of the fold and their valley walls are asymmetrically developed, being perceptibly steeper downdip.

Woodruff (1942, p. 97) related the slight southward slope of many flat-topped summit remnants in the vicinity of Wellsville to regional dip on resistant capping strata.

The bench-forming tendencies of the more resistant strata are evident in parts of the unglaciated area west of the Allegheny River. Whereas dominantly shaly sections tend to develop gentle slopes because of their lack of resistance to erosion, the massive and resistant beds support subdued scarplets. A typical situation involves marked steepening over sandy strata near the top of the Chadakoin group beneath a gentle slope developed on Cattaraugus shale. The Salamanca conglomerate in places supports distinct benches, and higher in the section, the Knapp and Olean conglomerates cap local plateau remnants.

Picturesque features of the Appalachian Plateau are the "rock cities" produced by weathering of exposed scarplets capped by strata such as the Salamanca, Knapp and Olean conglomerates. Conditions favorable for the development of rock cities include massive bedding, widely spaced jointing, high permeability and resistance to weathering in the capping layer, and the presence of an underlying shale. Although the most striking "rock cities" are in unglaciated portions of the plateau, others have apparently developed within the past 13,000 years. Weathering along joint planes permits downward movement of ground water which percolates along bedding planes. In time basal sapping produces a low slope and aided by processes of mass wasting widens the joint planes into narrow angular passageways reminiscent of city streets between high-walled buildings. Progressive weathering causes rounding and decrease in average size of the boulders which have been longest in transit and have moved farthest downslope from the ledge. Frost processes more intense than at present may have played a role in development of some "rock cities".

#### PRE-GLACIAL EROSIONAL HISTORY

Of the long and probably complex erosional history which followed uplift of the Paleozoic strata above sea level only incomplete evidence remains. It is commonly assumed that uplift took place in a succession of pulses before and during the Appalachian orogeny which brought the Paleozoic Era to a close. By virtue of its position northwest of the axis of major deformation, the region of Allegany County probably developed drainage north or northwest. In course of time the region was reduced nearly to base level with development of a peneplain which has been variously referred to as the Schooley, Kittatinny and Upland peneplain (Cole, 1938, p. 196). Lack of pre-Pleistocene deposits preserved on the upland surface makes precise dating impossible. Estimates of the interval since peneplanation are based on evaluation of the time required for subsequent renewed uplift, dissection and slight reduction of the surface. Such estimates range from Cretaceous to Miocene, with recent consensus probably favoring the later date and shorter interval since peneplanation.

In Allegany County the Upland peneplain is represented by closely accordant summit levels. Reconstruction of the peneplain on the basis of present summit elevations shows a surface of low relief which bevels structure, exposing progressively older beds

northward. The close conformity of summit level within the glacial border and in the Salamanca re-entrant shows that glaciation exerted a very subordinate effect in reducing the upland remnants in southwestern New York. Regional slope on the reconstructed surface is north, west and east from the highest region in southern Allegany County, at gradients of several tens of feet per mile (Woodruff, 1942, p. 94-97). This slope may reflect either initial relief, subsequent slight warping of the peneplain, or differential reduction of summits on strata of dissimilar erosional resistance.

Subsequent rejuvenation of the peneplain probably took place unevenly with intermittent uplift interrupted by intervals of stability with initiation of one or more intermediate erosion cycles represented by intermediate summit levels and straths described elsewhere in the Appalachian Plateau (Cole, 1938, p. 196).

The Tertiary peneplain presumably was covered by a residual soil mantle 10 to 30 feet thick prior to uplift. Reduction of the upland surface since rejuvenation has removed all trace of any such paleosol even in the unglaciated portions of the plateau. How much additional denudation may have occurred is difficult to estimate. Woodruff (1942, p. 97) suggests that summits in the eastern part of Greenwood quadrangle occur at intermediate elevations because they are developed on shale whereas higher summits to the west are capped by coarser and thicker units. In Potter County just across the state line from southern Allegany County, Denny (1956b, p. 49) shows that the upland surface reflects differential erosional resistance of bedrock and infers that average reduction of upland remnants by 75 to 100 feet has taken place within the Pleistocene Epoch.

Northwestward migration of drainage divides may have brought north central Pennsylvania into the watershed of the ancestral Susquehanna before the onset of Pleistocene glaciation, but preglacial drainage in New York is commonly conceived as being northward by the ancestral Genesee and Allegheny Rivers into a hypothetical "Ontarian River" along the axis of present Lake Ontario. The mature valley of the Genesee upstream from Portageville is considered to mark a part of the preglacial course of this river, but the valley from Portageville to Canaseraga Creek has been cut as a result of late glacial diversion. The Allegheny River likewise follows its preglacial course in the field area but westward the ancestral valley is blocked and deeply filled with glacial debris where formerly the river flowed north past Randolph and Gowanda.

#### PRE-WISCONSIN GLACIAL HISTORY

The maximum extent of glaciation coincides closely with the Allegheny River in the field area, but there is evidence of at least one temporary blockage of the river by ice prior to the Wisconsin stage. Marginal drainage channels near Quaker Bridge in western Cattaraugus County indicate that the glacier at one time extended across the Allegheny valley and against the unglaciated upland to the east at an elevation of at least 1570 feet. Kame deposits one mile east of the confluence of Oswayo Creek with the Allegheny River have been interpreted as indicative of ice marginal deposition into a proglacial lake impounded in the upper Allegheny valley (Bryant, 1955, p. 65).

High gravel terrace remnants in the Allegheny valley are ascribed to pro-glacial deposition in Illinoian time on the basis of depth of leaching, intensity of weathering and height above the present flood plain. One of the largest of these remnants occurs two miles west of Olean and stands nearly 100 feet above the present flood plain. Till of probable Illinoian age is described in Woodchuck Hollow, 3 miles north of Olean, as containing a larger proportion of carbonate and igneous pebbles than are found in the overlying Olean drift (MacClintock and Apfel, 1944, p. 1147). The plausibility of this correlation is confirmed by radiocarbon dating of wood overlying similar weathered till at Otto, about 28 miles northwest of Olean. Because the wood is of age greater than 35000 years, the interval of weathering is inferred to represent the Sangamon interglacial stage and the underlying till is therefore Illinoian (Suess, 1954).

## EARLY WISCONSIN GLACIAL HISTORY

Following the Sangamon interglacial stage which was milder and of longer duration than post-glacial time, Wisconsin ice spread southwest across the field area, reaching its terminal position in southwestern Allegany County and Central Cattaraugus County. The Wisconsin drift border is highly irregular and conforms to bedrock topography. Favored by the trend of Oil and Olean Creeks (Olean, N.), a large ice tongue spread into the Allegheny Valley to a point 4 or 5 miles west of Olean. This ice tongue overrode Illinoian terrace gravels and impounded a shallow body of water in the upper Allegheny valley. The Camel Back (Olean, SW) owes its notched profile to the dumping of lateral moraine against a bedrock knoll cut off from the spur to the south by a conspicuous marginal drainage channel.

Smaller ice tongues extended southwest in the valley of Dodge Creek as far as Portville, and in the valley of the Little Genesee River as far as Ceres where the end moraine is well developed. Near South Bolivar the Wisconsin drift border passes across the state line into Pennsylvania, angling southeast toward Williamsport.

Differentiation of Wisconsin drift sheets in the Appalachian Plateau have been based primarily on differences in pebble lithology, on variations in the depth of leaching of calcareous material, and under favorable conditions on continuous tracing of ice marginal deposits and features. The early Wisconsin or Olean drift (MacClintock and Apfel, 1944, p. 1153) has a pebble lithology composed essentially of the sandstone, siltstone and shale of the Devonian bedrock which underlies the plateau. Only two to five per cent each of carbonate and crystalline pebbles typically occur in the Olean drift, but in this latter far-traveled fraction occur cobbles apparently derived from the Champlain trough east of the Adirondacks, indicating ice movement from the northeast. Leaching to a depth of 10 feet or more is characteristic of Olean gravels. The drift sheet is generally thin and can be traced only with difficulty where it crosses uplands between valleys aligned in the direction of dominant ice movement.

The waning Olean ice sheet is presumed to have receded unevenly across the deeply dissected topography of southern and central Allegany County. Active ice movement probably persisted in valleys oriented in the direction of regional ice movement after the thinning ice became stagnant on the uplands or where it was cut off from its supply by an obstructing ridge. In the through valleys, ice retreat was by backwasting which resulted in marginal deposition at successive positions along the valley edge. Kame terraces deposited in this manner by the retreating Olean ice sheet occur from the Pennsylvania border north to Belvidere (Angelica, SE) along the Genesee Valley. Over the uplands, on the other hand, ice wastage was largely by downmelting with dead ice persisting in suitable locations even after bare ridges were exposed to the north. An area of kames and kettles deposited as the result of such a situation is located at an altitude of 2200 feet above sea level,  $1\frac{1}{2}$  miles south of Andover (Wellsville, E) (See also Map 1).

During wastage of the Olean ice sheet meltwater streams cut notches as much as several hundred feet deep across the divide between the Genesee and Allegheny watersheds. Some of these notches were cut by streams flowing along the ice margin whereas others were outlets for short-lived lakes impounded in front of the ice in northward opening valleys. A number of the more deeply cut notches afford natural passes followed by highways and a railroad as listed below:

<u>Name and Location of notch</u>	<u>Divide Elevation</u>
Notch 4 miles south of Cuba (Olean, NE)	c. 1750 ft.
North at Borden (Belmont, NW)	1692 ft.
Clarksville Notch (Belmont, W)	c. 1990 ft.
West Notch (Belmont, C)	c. 1970 ft.

East Notch (Belmont, C)	2111 ft.
Notch at Vosburg on Route 17 (Belmont, S)	c. 1950 ft.
Notch north of Pikeville (Belmont, SE)	c. 2000 ft.

Honeoye and Cryder Creeks occupy deep and open valleys obviously inherited from streams more competent than exist there today. The valley of Cryder Creek is narrow and deep, but flat-bottomed and marshy right across the divide at 1867 feet above sea level (Greenwood, W and SW) into the present watershed of Bennett Creek. Across this col flowed the glacial waters impounded south of the ice front in the valleys of both Bennett Creek and Colonel Bills Creek. Joining the waters of proglacial Lake Wellsville in the upper Genesee Valley this drainage crossed the divide into the Allegheny watershed, cutting the open, flatbottomed col at 1602 feet above sea level at the head of Honeoye Creek (Wellsville, SW).

The Olean substage of the Wisconsin has been tentatively correlated with the Tazewell of the Mississippi basin (MacClintock, 1954) and referred to an Iowan-Tazewell complex (Flint, 1954). In the light of present radiocarbon data it seems probable that the interval was no more than a few thousand years between recession of the Olean ice sheet and renewal of glaciation during the subsequent substage.

#### LATE WISCONSIN GLACIAL HISTORY

Readvance of the ice sheet in late Wisconsin time was from a direction more nearly north than northeast, reflecting probably a shift in the conformation of domes of maximum ice accumulation. Erratic cobbles are "common to the Grenville province of Ontario and the western Adirondacks" (MacClintock and Apfel, 1944, p. 1156). By contrast to the underlying Olean till the late Wisconsin gravels and till are bright and clean-looking because of their higher content of carbonate and crystalline pebbles and lower proportion of drab and brown "plateau rock". A representative sample of this drift contains 5 to 12% of igneous and metamorphic pebbles and 12 to 25% of carbonate pebbles. The name Binghamton drift was given this material in Cattaraugus County and mapped in reconnaissance across Allegany, Steuben and adjacent counties by MacClintock and Apfel (1944, p. 1156).

The Binghamton drift border lies along a line from Ischua to Cuba Lake, thence eastward along the south wall of the valley of Black Creek (Angelica, SW and S) to the Genesee Valley where an ice tongue extended south to Belvidere (Angelica, S). From Belvidere northward the border lies along the east side of the Genesee Valley, projecting eastward into tributary valleys and passing from the northeast corner of the Angelica quadrangle onto the southwest corner of the Nunda sheet. Breasting the upland at 1900 feet south of Dalton (Nunda, SW) the moraine curves southeastward past Swain and Canaseraga (Canaseraga, NE). Thence, south past North Almond to Alfred Station (Canaseraga, SE) and Canisteo (Hornell, S) the border lies along the southwest wall of Canisteo Valley projecting southward up valleys of right bank tributaries.

Topographically, the Binghamton drift border is marked by massive kames and valley-stopper moraines with sharp unmodified relief in contrast to the rounded expression of older drift deposits. A typical association of such kettles and kames can be seen near Alfred Station (Canaseraga, SE). A well developed valley-stopper moraine occurs 4 miles west-southwest of Canaseraga where deposition of the associated outwash plain built up a flat, swampy valley bottom and shifted the Black Creek-Canaseraga Creek drainage divide several miles to the northeast (Canaseraga, N). Proglacial streams of short duration notched the divide to produce cols followed by present highways at Tip Top (1772 feet above sea level, Wellsville, NE), and Five Corners (2034 feet above sea level, Canaseraga, SE). Glacial meltwaters from all Allegany County reached the Allegheny River via the Honeoye channel (Wellsville, SW) briefly re-establishing Lake Wellsville, a lake about 15 miles long in the upper Genesee Valley.

Halfway between Almond and Hornell (Hornell, W) Canacadea Creek is diverted from a broad but partly drift-filled valley trending northeast into a narrower southeast trending bedrock valley. A sag which extends about 2 miles southwest from Webbs (Hornell, W) is the drift-obstructed extension of the interglacial valley of Canacadea Creek. Inasmuch as Binghamton till occurs at creek level two miles northwest of Hornell, stream diversion must have taken place prior to the Binghamton advance.

Although he recognized the possibility of alternative correlations, MacClintock (1954) considered the Binghamton moraine to be of Early Cary age. Recent radiocarbon dating of marl and basal peat from a depression marginal to the Binghamton moraine at Corry in Erie County, Pennsylvania appears to substantiate this correlation. Dates on marl and peat deposited following recession of Binghamton ice from its terminal position range between 13,000 and 13,900 years ago, corresponding to the end of the Early Cary in the Mississippi Valley type area (G. W. White and John Droste, personal communication).

Stagnant ice deposits marking progressive withdrawal of the ice border are distributed northward from Belfast (Angelica, C) along the Genesee Valley. A significant stillstand during the Binghamton recession is marked by massive and extensive valley-choking kame complexes such as those at Machias (Franklinville, NW), Sandusky (Franklinville, N) and Hardy's Corners (Franklinville, E) (Also see Map 1). Northward withdrawal of the ice margin from the valley of Black Creek exposed the low divide east of Cuba Lake (Franklinville, SE). Opening of this outlet for proglacial waters impounded in the upper Genesee valley resulted in abandonment of the Honeoye outlet channel and initiated Lake Belfast-Fillmore controlled by Cuba outlet at present elevation of 1496 feet above sea level.

In central New York east of the Genesee River the divide between the Susquehanna and St. Lawrence watersheds is generally determined by massive moraines of the Valley Heads system. During this glacial episode the ice terminus in the Genesee Valley stood at Portageville (Portage, SE), re-instating Lake Belfast-Fillmore by blocking outflow to the east past Dalton (Nunda, SW). The age of the Valley Heads moraine is established as Late Cary by radiocarbon dating of wood deposited on the outwash plain at Chaffee in the southeastern corner of Erie County, New York. Occurring at the base of a marly silt overlying outwash gravel, and dated at  $12,020 \pm 300$  years the wood should closely postdate the maximum extent of Valley Heads ice (Meyer Rubin, personal communication).

Withdrawal of ice from the Valley Heads terminal moraine exposed very short-lived outlets at Dalton (Nunda, SW) and subsequently at Burns (Hornell, NW). Briefly, during the effective lives of these outlets proglacial Portgage Lake and Lake Dansville, respectively, extended up the Genesee Valley into northern Allegany County. Exposure of lower outlets westward past Batavia into the watershed of Lake Chicago terminated pro-glacial lake history in Allegany County.



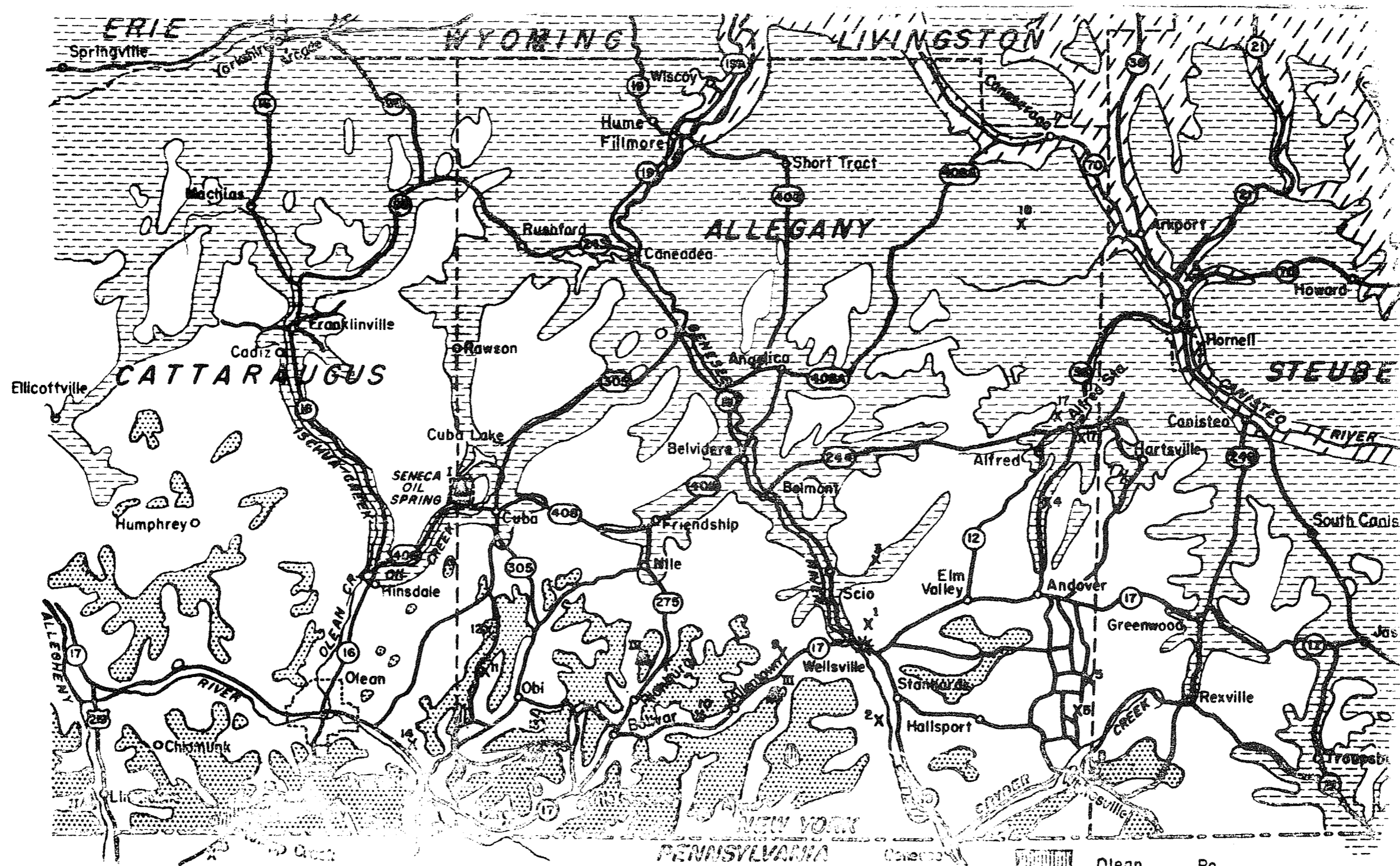
## TABLE 1 - GEOLOGICAL EXPOSURES IN THE WELLSVILLE AREA

- Sta. 1. Type locality of Wellsville member north of Wellsville, N. Y.  
 Sta. 2. Hinsdale with some Wellsville at base of outcrop in road cut along Fords Brook.  
 Sta. 3. Cuba with Machias at base of outcrop in road cut east of Scio along Vandermark Creek.  
 Sta. 4. Machias in road cut on Route 36 between Andover and Alfred Station, New York.  
 Sta. 5. Germania topping hills between Andover and Whitesville, New York  
 Sta. 6. Dunkirk exposed in abandoned quarry north of Hornell with Wiscoy exposed below Dunkirk.  
 Sta. 7. Reverse fault in Purdy Creek.  
 Sta. 8. Type locality for Whitesville.  
 Sta. 9-10. Probable Whitesville on Route 17 between Wellsville and Bolivar, New York.  
 Sta. 11. Wolf Creek conglomerate in quarry south of Cuba and north of Portville, N.Y.  
 Sta. 12. Type locality of Wolf Creek conglomerate north of Number 11.  
 Sta. 13. Olean conglomerate an oil lease north of Little Genesee, New York.  
 Sta. 14. Glacial exposure in cut along Erie railroad between Olean and Portville, N.Y.  
 Sta. 15. Cattaraugus red beds and Oswayo exposed in road cut one mile south of New York-Pennsylvania state line on Pennsylvania Route 646.  
 Sta. 16. Type locality of Olean conglomerate at Rock City, New York.  
 Sta. 17. Binghamton glacial moraine at Alfred Station.  
 Sta. 18. Rushford.

PLACES OF HISTORICAL OIL AND GAS INTEREST IN THE WELLSVILLE AREA  
(From Kreidler, 1953)

1. 1627 The Cuba or Seneca Oil Spring, near Cuba, New York has generally been credited by early historians as being this original occurrence of petroleum. Father de la Roche de Allion, a Franciscan missionary, in a letter dated July 18, 1627, was the first to mention the occurrence of petroleum on the North American continent. In 1857 the first test well specifically drilled for oil on the North American continent was near the spring. It was drilled to a depth of 600 feet but did not prove to be commercially productive.
11. 1865 In New York just west of Limestone, oil was found at a depth of 1060 feet in the Bradford third sand.
111. 1879 The Triangle No. 1 well, the discovery well of the Allegheny field, was drilled by O. P. Taylor. The top of the 27-foot oil sand was found at 1126 feet and the well was drilled to 1177 feet.
- IV. 1928 Gilbert No. 1 well produced gas from the Tully limestone or top of the Hamilton. This well started a deeper exploration drilling program in the southern and southwestern counties of New York and north-central Pennsylvania which led to the discovery of the Oriskany sandstone gas fields of that area. After depletion of this gas well, it was made a storage well.





**MAP 2**  
**GEOLOGICAL MAP OF WELLSVILLE AREA**  
 0 5 10 15 20 MILES

X Station numbers of geological exposures  
 ⚠ Places of historical oil and gas interest

	Olean	Po
	Conewango	Dco
	Chadokoin	Dcha
	Canadaway	Dca
	Chemung	Dchs